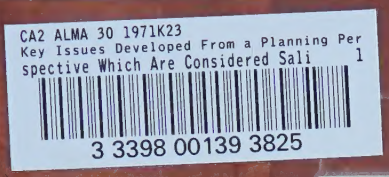

LOCATION OF NOXIOUS
INDUSTRY RELATED
TO RESIDENTIAL DEV.

WORKING PAPER NO. 1: Prepared for the
Department of Municipal Affairs

OUTLINING:

KEY ISSUES DEVELOPED FROM A PLANNING PERSPECTIVE WHICH ARE CONSIDERED SALIENT IN PROVIDING FOR GUIDELINES WHICH WOULD GOVERN THE SUCCESSFUL CO-EXISTENCE OF NOXIOUS INDUSTRY AND HOUSING

Prepared by: A. E. Gordichuk
W. Jackson

Research Section
Provincial Planning Branch
Department of Municipal Affairs

Noel Dant, Director

JANUARY 1971

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INTRODUCTION

In recent years atmospheric pollution and the rapid deterioration of the environment have become matters of major interest and concern throughout North America, in both rural and urban areas. The literature on this subject is vast and the causes of "pollution"[1] most numerous.[2] The predictions and forecasts made in the literature, can be described as, at the least, frightening. Government departments and private agencies and groups are now thoroughly involved with the question.

Much of the discussion related to urban areas focuses on industry. Industrial growth is often synonymous with urban growth. The availability of labour, the size of the market, and the proximity to other industries help make the large urban centre an attractive location for many industries. Inherent in the processes which a number of these industries use is the release of waste material in solid, liquid and gaseous forms, as well as a certain amount of noise, odour and vibration. While much of this can be measured and controlled, it is either technically or economically impossible to completely eliminate it.

Alberta is experiencing rapid industrial and urban growth and is not without some of the related problems. A great deal of concern has recently been shown by both public administrators engaged in land use control and industrialists engaged in heavy processing industries over the proper designation of

[1] The term is used in the broadest sense.

[2] See Appendix A

land use in the neighbourhood of such industry and over the mutual impact of residential and industrial uses. It is this issue which is the subject of this brief. The central question is how to both control and plan for the effect noxious industry has on nearby residential uses. Examples of the importance of this matter have been shown by recent Supreme Court decisions related to Northeast Edmonton,[3] and the controversial location of the Ogden residential district in Southeast Calgary.

This problem of land use control is being examined by the Provincial Planning Branch at the request of the Office of the Minister of Municipal Affairs. This brief will present a general discussion of the problem, including an outline of methods by which it can be studied in depth, and make recommendations which, hopefully, will lead to major policy decisions.[4] Background material for the paper was gathered both by careful examination of the literature, some of which is mentioned in the bibliography, and by a selected number of personal interviews with individuals and agencies directly concerned with the problem.[5]

3 Refer to the document "The Provincial Planning Board Transcript of Hearing" held September 22 & 23, 1969 at the Jubilee Auditorium, Edmonton, Alberta

4 The brief is written with a planning perspective and, unless otherwise noted, any opinions expressed are those of the writers. The subject, however, is within the interest of numerous disciplines and must eventually be interwoven with contributions from those disciplines.

5 These included: W. S. Ziegler, Chairman of the Board, Inland Cement
I. Hause, Development Control Officer, County of Strathcona
S. Dobko, Environmental Health, Air Pollution
E. W. Kupchanka, Environmental Health, Water Quality
T. Brown, City Hall, Research, City Planning Division
G. C. Heald, Calgary Planner, Long Range Division
P. Bonnett, Graduate Student, Department of Geography
M. Rogers, Director, Calgary Planning Department
R. N. Giffen, Director, Edmonton Regional Planning Commission

INDUSTRY, POLLUTION AND THE URBAN RESIDENT

In the 18th and 19th centuries it was necessary for workers to live close to their place of employment. With improved transportation, however, workers were freed from this necessity, and the dispersal of residences and residential areas has since taken place. The impact of this process has led to the organized division of urban space by means of zoning and development control bylaws. Ideally this is advantageous to both would-be residents and industrial interests. The report by the Edmonton Anti-Pollution Group points out (pp. 4-5) that air pollution (a) "causes the accelerated deterioration of materials, structures and machines of all kinds," and "that this in turn increases maintenance and replacement expenditures"; (b) "is responsible for a general depreciation in property values" and (c) effects human health in areas ranging from aesthetic insult, to discomfort (eye, ear, nose and throat irritations) to illness (respiratory ailments) and death. The willingness of the resident to endure any inconveniences or discomforts created by nearby industries depends a great deal on his perception of the environment and this in turn reflects personal priorities and socio-economic position. A person may only be able to afford to live in an area where land values are relatively low, or he may prefer to live close to his place of work and reduce the time and cost of the journey to work.[6]

[6] There are two schools of thought on the question of what happens to people upon moving into an area adjacent to industry. One believes they eventually become insensitive to any odour or noise, while the other believes that the people soon become dissatisfied and the desire move increases. It is probable that both schools have merit.

If residential and industrial areas are adequately separated the industry, in turn will also gain. It would not be harassed by nearby residents and petitions eventually forcing the industry to move elsewhere as would likely be the case where adequate separation is not planned. It could eliminate the necessity of providing expensive pollution control devices where otherwise this would be required. It would allow for plant expansion, where otherwise the possibilities of expansion might be blocked by the proximity of housing to the expansion area, though this would be just as undesirable as the reverse process. A company may, however, prefer to have its employees living close by to reduce lateness. It may also wish to locate in or adjacent to a developed area which could easily be served by public transportation and this would eliminate transportation costs often incurred where plants are located in outlying areas.

It appears then that, if planning is in any way concerned with the ultimate welfare of the people, the proximity of residential or potential residential land should be a prime factor in determining the location of heavy industry. Such would not only benefit the resident and the industry, but also the city:

> Industrial uses constitute a fundamental base for the economy of the City, and it is in the very interest of the City to ensure that the industrial uses may continue to operate on a sound economic basis and that by the zoning and subdivision of adjacent lands the operation of these basic issues must not be prejudiced.[7]

Before exploring this question further, however, it is necessary to look at the present situation in Alberta.

[7] S. C. Rogers in the "Provincial Planning Board Transcript of Hearing", held September 22 & 23, 1969 at the Jubilee Auditorium, Edmonton, Alberta, p. 22

INDUSTRIAL POLLUTION CONTROL

The Environmental Health Division under the Department of Health and as described in the Public Health Act has largely been responsible for pollution control in Alberta. Industrial pollution control has taken two main directions: one dealing with the relative location of the industry and the other attempting to control the emissions by technical devices at the source. The above mentioned division imposes specific emission limits on established industries to ensure compliance with provincial water and air quality standards.[8] The regulations appear to prevent the emissions from being toxic, and there is a provision for fines to be levied for offences. This brief assumes that regulations used for the purpose of controlling emissions at the source are adequate and well enforced. Past efforts at controlling pollution were aimed at spatially distributing sources in such a manner that pollutants were disseminated over open areas rather than developed areas. The adoption of general plans and zoning controls have achieved this in the past. However, based on land use alone they have had little control over the concentration of industrial plants on a given unit of land.[9] Assuming that emission standards are both adequate and enforced, toxic elements are not the issue. Subsiduary influences such as noise, smoke, odour, dust, dirt, glare, heat, fire hazards and psycological effects have little or no acceptable tolerance levels established for the mutual protection of both residents and heavy industry

[8] See Appendices B and C

[9] Williams et al, p. 3

in close proximity to each other. Zoning as a means of pollution control can be effective only with the application of such knowledge.

The most controversial parameter used by the Environmental Health Division in determining the location of a newly proposed industrial site is the one-mile exclusion zone. It was established in 1961 by the Division of Sanitary Engineering as a 'rule of thumb' and states as follows:

> that in the future the distance between residential areas and industrial areas being one mile in all cases where no noise or odours are a factor, lesser distances should be considered only if the appropriate separation of topography, trees or higher buildings is present, or if the industry establishing the area is prepared to operate at a consistently high performance standard. (Provincial Planning Board, p. 23)

The one mile limit is designed to act strictly as a buffer zone and is not supported by any professional study. Industry, of course, favors this rule because the intensity of pollutants decreases considerably through the one mile distance. As yet, devices and techniques are not available for the control of all contaminants, particularly for noxious odours or noise. Even though ameliorative technical devices may be used some noxious effects are less controllable under particular climatic conditions. In addition industrialists agree that during various stages of production (particularly in chemical processing) when plant failures are more common (leaks, valve problems, spills, etc.) uncontrollable odours may prevail many times in the course of a year. Urban administrators agree that no industry should render land unapproachable simply because it produces obnoxious odours or toxic elements. A buffer zone rule should not act solely as a tool relieving industry from expensive control devices.

The buffer zone does not necessarily have to sterilize valuable land. Other types of mixed and complementary land uses such as commercial and light industry can sometimes 'fill the gap'.

TOWARDS A SOLUTION

The growth of heavy industry and urban population often occur simultaneously. Heavy industry lowers air quality levels in the area as a whole and in nearby residential areas in particular. Both the proportion of the total population living in cities and towns and the variety of human activities are on the increase. Industry is often a necessity. Therefore, how can the obnoxious side effects of industry, side effects which cannot be eliminated, be minimized?

The air pollution problem, of course, is not as critical in Prairie cities as it is in Montreal or Toronto. Populations are lower, cities are industrialized to a lesser degree and are relatively free from summer fog. Given, however, that the level of pollution apparently increases with industrialization at an increasing rate and that there are already numerous examples of areas in Alberta suffering from prevailing noxious elements, the time to attack the problem is now, before it becomes as grave as elsewhere. Little can be done about existing problems, but a serious effort is needed to prevent similar and potentially more critical situations from arising in the future. This brief submits that at the present time the problem does not lie solely with an inability to provide adequate abatement policies at the source, but is also to provide guidelines for site location policies in the proximity of nearby residents. It is one of location.

There are a number of factors which influence the build-up of pollutants, irregardless of the type of industry. The topography of an area may be a major determinant of the air quality level. Physical features influence the micro-climatic situation and air drainage is strongly affected by the terrain.

Low valley areas with little air movement and localized pressure usually provide poor sites for industry from a pollution point of view. Meteorological characteristics too are of considerable importance. Wind speed and direction strongly effect the dispersal capabilities of the atmosphere. Temperature inversions prevent the escape of any emissions. Insolation and precipitation may also be of some importance.

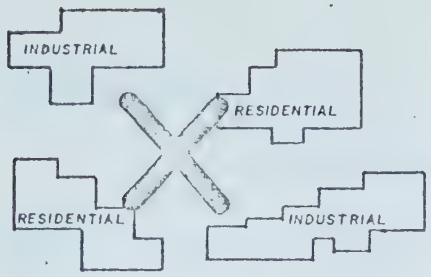
> The dispersive ability of the air at each possible site has to be determined on the basis of average values for wind movement and inversion conditions ... in considering each possible site for the location of a plant, the industry has to balance the factors relating to availability and cost of control of air pollutants against site advantages. (Stern, p. 605)

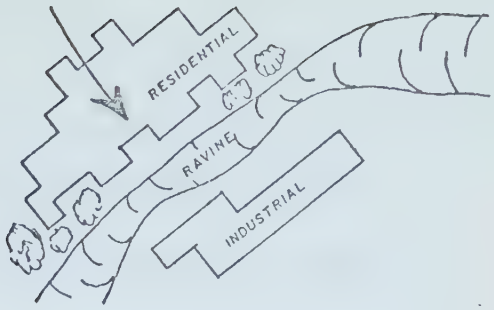
In future, planning must ensure that concentrated air pollution (and related obnoxious elements) does not occur as a result of industrial location, and that industrial by-products such as noise, gas, and odour are blown or drift over thinly populated areas (see diagram I).

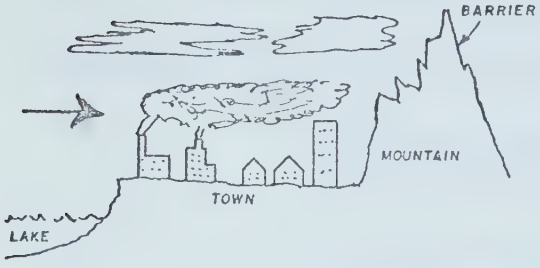
In attempting to reach this goal the one mile limit is a good start, in principle, but it should not exist as a standard measurement compromise. The distance separating contrasting land use should vary with such factors as type of pollutant, micro-climate, wind direction and topography.[10] The one mile zone prohibits industry from certain locations, but does not prohibit residential encroachment within those same distances. Residential spread, however, must terminate at some point in space, yet must not be developed to create confined industrial 'islands'

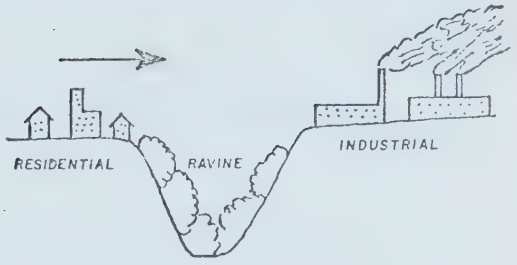
[10] See Appendix D, Inventory for Source Types, and Appendix E for Charts giving characteristics for Industrial Wastes.

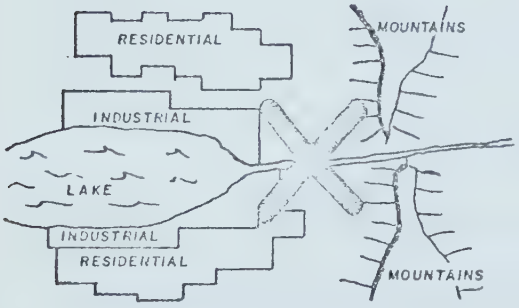
DIAGRAM I



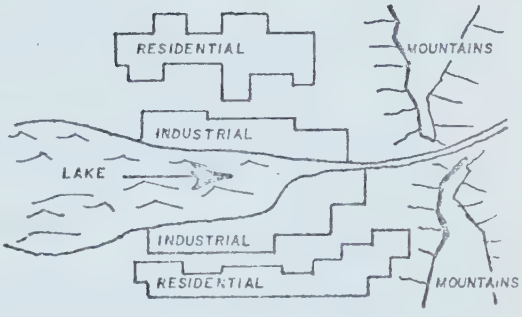


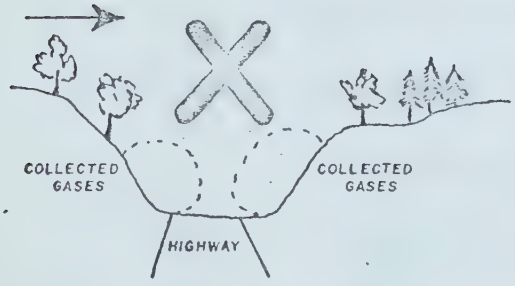


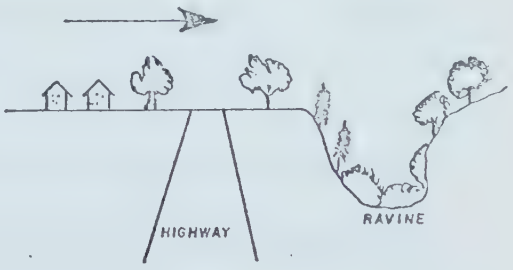


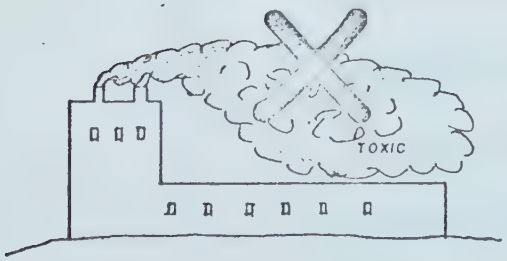


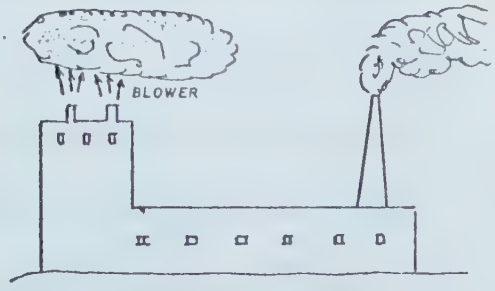
ILLUSTRATIONS INDICATING POCKETS OF AIR POLLUTION INVERSION AND RESIDENTIAL ANNOYANCE

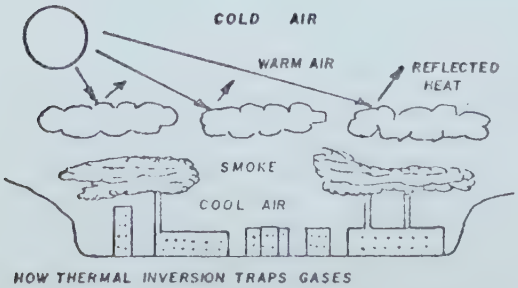




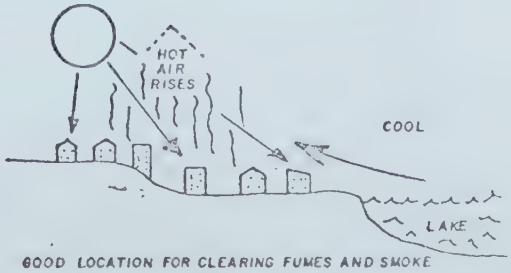








HOW THERMAL INVERSION TRAPS GASES



GOOD LOCATION FOR CLEARING FUMES AND SMOKE

within a large urban area.

Alternative forms of buffer zones should be implemented and supported by a clear understanding of the status of pollutants in a designated area. It would be necessary to professionally attain, as completely as possible, information on the following variables:

1. The source factors, such as types, numbers, distribution and emissions.
2. The meteorological parameters, such as wind speed, direction, stability and effects of terrain.
3. The quality of air on a temporal and spatial basis.
4. The adverse effects on the environment and people, associated with the corresponding conditions of air quality.

With this knowledge at hand, and given a performance type standard to follow, the size and location of buffer zones can be investigated. One very well defined set of spatial controls has been drawn up by R. Anderson (p. 147) and separates a buffer into three levels of acceptance:

1. Exclusion Area - means that area surrounding the industry, (industrial area) in which the industry has the authority to determine all activities including exclusion or removal of personnel and property from the area ... activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

2. Low Population Zone - means the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident (a permissible density or total population is not specified because of inherent geographic variables).

3. Population Centre Distance - means the distance from the industry to the nearest boundary of a densely populated centre containing for example, more than about 25,000 residents.

Such a division of space provides equal protection for both resident and industry.

A SUGGESTED COURSE OF ACTION FOR ALBERTA

Alberta has, at times, been singled out as the leader among the provinces in the battle against pollution. The Province, however, must not become complacent. This brief has emphasized the need to, in future, separate industrial and residential land use to the ultimate benefit and satisfaction of all concerned. To accomplish this a definite and stringent policy of industrial location is essential. It would be difficult and impractical, however, to legislate such a policy. The variables which are of importance in one particular case are numerous and wide ranging, and are usually somewhat different from those in every other case. A two-fold program would appear to be much more practical.

The first section of this program would involve a systematic study, assessment and analysis of the pollution problem (air) in every major urban-centred region in the province. The study would provide guidelines and recommendations that relate to the technical, legislative and administrative aspects of a pollution program. Many such studies have been suggested in the pollution control literature; however, one as diversified and complete as that used in Northern Illinois and referred to by Anderson (p. 45) is recommended. An outline of the study is shown on the following pages. Little adaptation appears to be necessary to make this research program applicable to Alberta regions. It is further proposed that such a series of studies should be undertaken by qualified organizations or individuals and headed by a central agency with experience in large-scale air pollution

studies.[11] By the very nature of the Northern Illinois outline a diversified program in Alberta would involve a wide range of professionals and carefully designed sample population surveys.

[11] Alberta is not without established authorities capable of either organizing or undertaking research programs associated with air pollution. The following authorities are:

Geo Science Research Association Ltd., Julian Kinisky
Western Research and Development Ltd., Calgary, Joe Lukacs
Dr. K. Hage, Dept. of Geography, University of Alberta (Meteorology)
Dr. Daniel (Pharmacology) Chairman, Interdepartmental Committee on Environmental Health
Dr. Summers, Alberta Research Council
Dr. Tolesfson, Chemical Engineering, University of Calgary

NORTHEASTERN ILLINOIS: AIR RESOURCE MANAGEMENT PROGRAM
(Source: R. Anderson, p. 45)

I. Data Gathering and Field Surveys

A. Examination of the nature, location and extent of existing air pollutants in the metropolitan area.
1. Assemblage of existing air quality data.
2. Assemblage of complaints.
3. Estimation of ambient air quality levels based on potential sources of emissions to the atmosphere.

B. Meteorological and topographic factors on a regional scale and their application to pollutant emissions.
1. General study of meteorological parameters.
2. Computation of correlation coefficients.
3. Effects of building and land forms.

C. Demographic, economic and land use considerations.
1. Assemblage of population data.
2. Assemblage of economic data.
3. Assemblage of land use data.

D. Effects of pollutants on health.

E. Regulations and Controls.

II. Data Analysis

A. The current situation: Relationship of pollutant concentrations and meteorological factors to the existing physical environment, population, economy and health in the metropolitan area.
1. Relationship to population and physical environment.
2. Relationship to economics.
3. Relationship to health.

B. Potential worsening of the problem: Relationship of pollutant concentrations and meteorological factors to the future physical environment, future population, economy and health in the metropolitan area.
1. Relationship to projected population and land use.
2. Relationship to the future economic picture.
3. Relationship to the future health of the metropolitan population.

C. Impact of technology and its relationship to land use.

(cont'd)

D. Relationship of air to land use.
   1. Multivariate statistical analysis.
   2. Qualitative analyses of specific land uses will be undertaken to determine their compatibility to certain natural features.

E. Relationship of air pollution control to alternative development patterns in minimizing air pollution concentrations for the greatest number of people within the metropolitan area.
   1. Consideration of specific development patterns.
   2. Use of models.
   3. Analysis of development patterns.

III. Preparation of Report - Recommendations and Implementations

A. Technical recommendations for optimum air quality in the metropolitan area with areal distribution.
   1. Suggested implementation of recommendations through local air pollution control ordinances including provisions for refuse handling and disposal, zoning, subdivision regulations and municipal and county master plans in meeting the objectives and policies of the study.
   2. Weaknesses and strengths of existing control measures.
   3. Role of air resource management in justifying future land use demands, locations and the optimum development pattern, including discussion of alternatives and specific land-use relationships in minimizing the effects of air pollution on future land use.

B. Administrative and legislative recommendations that will outline courses of action that will show how the technical recommendations can be made administratively and legislatively feasible.

C. Future research needs.

This second part of the program would involve a number of metropolitan air pollution control units.[12] The cities of Alberta at the moment have no control over pollution and therefore rely on special studies and agencies, especially the Provincial Health Authorities, in this matter.[13]

Given the areal source of most air pollution it seems sound, however, that the promotion of increased air quality (noxious emissions etc. included) be undertaken on the basis of city-centred regions, yet with overall control and financing remaining with the Provincial Government. Problems resulting from heavy industry are closely related to such factors as community facilities, local health, transportation and particularly land use planning, all of which are included in the comprehensive planning process at the metropolitan level. A "local control division" responsible for a specific city-centred area would act as a liaison between city, municipality or county governments and the provincial government.[14] A local control division could even participate in the comprehensive research program and would in turn aid in the implementation of the research programs'

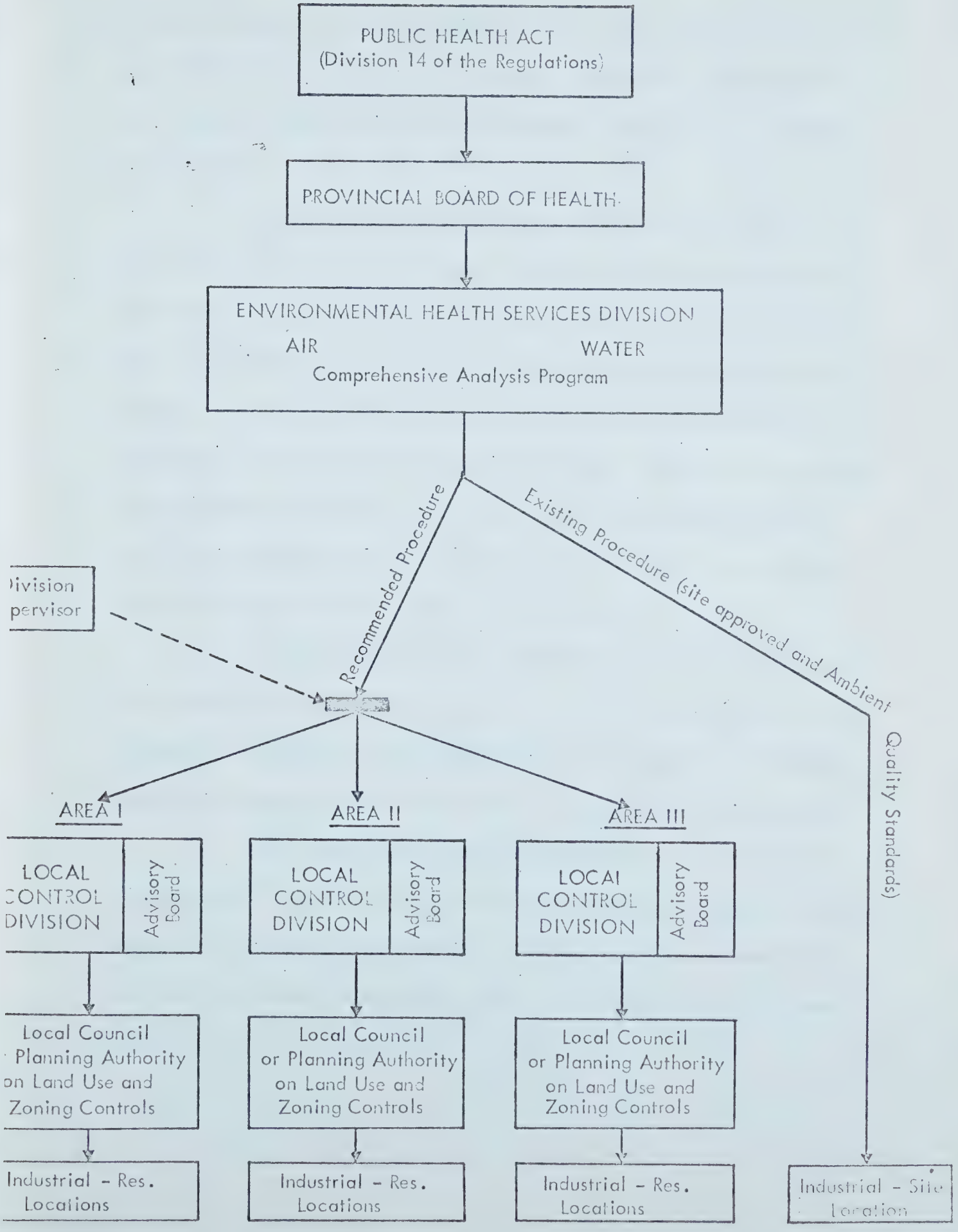
[12] This proposal is similar to one proposed by the Edmonton Anti-Pollution Group (Bonnett, p. 26) which reads as follows:

> A Metropolitan Air Pollution Control Unit should be set up with a geographical area of responsibility, enforcement power and finding provided by the Provincial Government. It would have the duty to assess and control pollution problems that are interrelated by virtue of their contribution to general and local problems in the city area. Visits should be set up for main urban areas which contain the problems.

[13] See Appendix F for Industrial Districts Zoning Regulations.

[14] Rather than create a completely new 'authority(s)' existing government bodies such as the Regional Planning Commissions, could implement pollution policy on an urban level.

DIAGRAM II


PUBLIC HEALTH ACT
(Division 14 of the Regulations)
PROVINCIAL BOARD OF HEALTH
ENVIRONMENTAL HEALTH SERVICES DIVISION
AIR
WATER
Comprehensive Analysis Program
Recommended Procedure
Existing Procedure (site approved and Ambient
Quality Standards)
ivision
pervisor
AREA I
AREA II
AREA III
LOCAL CONTROL DIVISION
Advisory Board
LOCAL CONTROL DIVISION
Advisory Board
LOCAL CONTROL DIVISION
Advisory Board
Local Council
Planning Authority
on Land Use and
Zoning Controls
Local Council
or Planning Authority
on Land Use and
Zoning Controls
Local Council
or Planning Authority
on Land Use and
Zoning Controls
Industrial - Res.
Locations
Industrial - Res.
Locations
Industrial - Res.
Locations
Industrial - Site
Location

findings and suggestions by local health units, local civic authorities and planning agencies in the form of bylaws, outline plans or general plans. The chart on the following page diagramatically explains the possible administrative organization (diagram II).

The preceding discussion suggests a controlled comprehensive approach to urban and regional planning. Not only can noxious industry locate relative to prevailing wind patterns or separated from other land uses by exclusion zones, but subdivision plans can be safely regulated through sophisticated zoning methods. The planner will have to understand the technical basis for source control and the provincial liaison authorities, familiarized with specific areas, would be responsible for the approach used. Each newly locating industry should be made aware of existing or proposed urban development in the vicinity, and the respective tolerance levels of noxious emissions to result.

It will no doubt be somewhat difficult to justify the establishment of a comprehensive program in an area which has not, as yet, reached the critical point in terms of pollution. Such foresight is however a necessity. It is virtually impossible to effect any land use change in an area once it has been developed.

The recommendations made in this brief are summarized on the following page. It must be remembered that they are concerned with only a limited aspect of an extremely complex problem. Pollution occurs in many forms and if man hopes to successfully confront the problem all of its variations must be considered.

SUMMARY OF BRIEF

- In the vicinity of heavy industry and residential areas pollution may cause a land-use conflict.
- While certain industrial emissions can be controlled, it is either technically or economically impossible to completely eliminate them.
- There are both advantages and disadvantages to industrial and residential areas if they are located in close proximity.
- The Alberta Public Health Act has regulations pertaining to toxic emissions from industry and the Environmental Health Division recommends a separation of industrial and residential uses of one mile.
- The effect of a pollutant on a residential area varies with the type of pollutant and a number of locational characteristics.
- Civic bylaws and zoning regulations have not dealt directly with the effects of air pollution.
- The brief recommends:
    1. The establishment of a comprehensive research program which would make proposals for the future prevention of industrial-residential land use conflicts due to industrial pollution.
    2. The creation of a number of city-centred regional pollution control divisions which would aid and advise local governments and planning authorities on the implementation of the findings and proposals of the research program and related matters.

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Appendix A: General Purpose Breakdown of Definitions, Terms and Controls

A. Illness Associated with Pollution

Impaired health of lungs and respiratory organs in urban areas; growth of children retarded because of lack of sunlight and the aging process accelerated; mental depression, loss of normal vitality and efficiency, chronic bronchitis and asthma; in certain cities, increased suicide rates; in smaller towns, chronic illnesses of unknown cause; several thousand deaths in major air-pollution disasters.

Annoyance, such as eye irritation, throat tickle, coughing, impaired driving ability.

Sky-darkening, and loss of sunlight, reducing disinfection of air by sunlight and increasing the possibility of spread of disease.

Reduced visibility, causing difficulties in traffic, reducing the beauty of the landscape, spoiling views and vistas, and eating up more electricity.

Soiling of surfaces, and the collection of dust and soot on buildings, laundry and clothing accounts.

Corrosion and abrasion of surfaces of buildings, caused mainly by acid pollutants such as dissolved sulphur oxides.

Decrease in crop value; blossoms lose the ability to fertilize, plants and fruits grow smaller and less tart, apples and peaches develop cracks in their skin; oats, beans, beets, spinach, tobacco retarded in production; trees cease to grow; animals grow slower, cows produce less milk.

Industrial production faces many uncounted losses; the paper and textile industries are sensitive to dustfall and smoke; increased radioactive fallout causes spots on photographic papers during protection.

B. Aerosols and Gases

Scientists place all air pollutants in two categories: Aerosols and Gases.

The aerosols embrace smoke, fumes, dust and mists. They are minute particles of matter, solid or liquid, suspended in the atmosphere. These particles diffuse light and thereby reduce visibility when enough of them are in the air.

The gases are nitrogen oxides, sulphur oxides, carbon monoxide, hydro carbons, aldehydes and acids. Ozone should be added to this list for it is a poisonous gas formed by nitrogen oxides reacting with hydrocarbons in the presence of sunlight.

Aerosols

Smoke contains both solid and liquid particles. It is the unburned product of incomplete combustion, emitted to the air from the burning of rubbish, the industrial burning of coal or petroleum products, or from the exhaust pipes of motor vehicles.

Fumes are solid particles. They are generated by condensation of vapors from solid matter or by sublimation, distillation, calcination, or chemical reaction. They are emitted by many manufacturing processes, such as those used in chemical, paint, rubber and metal industries.

Dusts are solid particles of moderate size. They are released from grinding, drying, sawing, or dusting processes, such as utilized in the rock, cement, asphalt, tile, metal, soap, dried foods, lumber, and rubber industries.

Mists are liquid particles and the commonest examples are fog and steam. Industrially, mists are released mainly in spraying, coating, and impregnating operations. An organic mist from auto exhaust is formed in the atmosphere by the action of sunlight on olefinic hydrocarbons and nitrogen oxides.

Gases

Nitrogen oxides are formed by all combustion and by certain chemical manufacturing operations. Whenever anything is burned, some of the nitrogen (N) in the air combines with some of the oxygen (O) to form nitric oxide (NO). This gas in turn combines with more oxygen and forms still another gas, nitrogen dioxide (NO_2).

Under intense sunlight, nitrogen dioxide reacts with olefinic hydrocarbons to produce eye irritation, vegetation damage, and visibility reduction. This is referred to as a "photochemical" reaction.

Ozone is the one gaseous air pollutant that is not emitted as such into the air. It is formed when nitrogen dioxide (NO_2) absorbs energy from the sun and then breaks down into nitric oxide (NO) and oxygen (O). This single atom of oxygen (O), aided by the presence of olefinic hydrocarbons in the atmosphere, combines quickly with an oxygen molecule (O_2) in the air and ozone is formed. No other method for the formation of significant amounts of ozone is known.

Sulphur oxides are formed chiefly by burning coal or fuel oil for industrial and commercial heating, from burning fuel gas containing oxygen sulphide in refineries, and from smelting processes. This gas is colorless, with a suffocating odor. In fog, some of it may be changed to sulphur trioxide and sulphuric acid mist.

Carbon monoxide is formed by incomplete combustion of any substance containing carbon -- coal, petroleum products, natural gas and even charcoal.

Hydrocarbons are compounds containing only hydrogen and carbon. There are four classes of hydrocarbons -- paraffins, aromatics, naphthenes, and olefins. Hydrocarbons enter the atmosphere chiefly as unburned or partially burned gasoline from motor vehicle exhausts.

Aldehydes contain carbon, hydrogen and oxygen, and may be formed as a result of incomplete combustion or from the action of sunlight on nitrogen dioxide and olefinic hydrocarbons in the atmosphere. (The Air Pollution Foundation has determined that acrolein and formaldehyde are the major eye irritants in Los Angeles' smog.)

Acids are usually organic. They contain carbon, hydrogen, and oxygen. Most are formed by incomplete combustion, although some are formed in certain industrial processes, and others by the "photochemical" process.

There are also gaseous inorganic acids, of which hydrogen flouride is the most significant. This is the only known toxic gas in the atmosphere that contains flourine.

C. Where it Originates

Air pollution originates from incomplete burning, inefficient combustion engines and many industrial processes. It reaches dangerous proportions if many exhausts are concentrated in high populated areas.

The main sources:

Gasoline and Diesel automobiles. They produce two-thirds of the pollution in Los Angeles.

Coal-powered locomotives and ships. But gradual elimination of steam locomotives in favor of diesel engines in diminishing this source.

Garbage disposal. (When material is burned in inefficient incinerators or when open dump burning is permitted.)

Heating units for buildings. (These have been described as the greatest single pollution problem in major cities.)

Thermal power plants. (Where improperly located and producing large amounts of sulphur oxides.)

Manufacturing plants -- such as steel mills; metal smelting and refining; pulp and paper mills; cement factories; gravel, stone and other aggregate producers; brick-burning; asphalt plants; oil refineries; coke manufacturers; fertilizer plants; paint manufacturers; automobile manufacturers; producers of tires and rubber; metal-reclaiming plants; foundries; manufacturers of plastic and synthetics; chemical industries, i.e. producing sulphur and sulphuric acid, ammonia; glue manufacturers; soap factories; textile industries; food industries, meat packing and rendering, grain elevators.

Smokers. In Ontario, they blow 12 tons of pollutants daily into the air. During the 1959 World Series baseball game in Los Angeles, a heavy smoke cloud hung stagnant over the Coliseum and its 100,000 occupants.

Airplanes. Jet planes are an increasing source.

Dirty Streets, construction projects and pollen-producing weeds.

D. Solid Pollutants

Ashes and cinders are mainly 50 mu. and larger, containing silica oxides and carbons. They settle readily in quiet air, producing the dustfall in towns and cities. Particles of 100 to 200 mu. settle rapidly and fall in the immediate vicinity of the exhaust stacks.

Smaller microscopic solid particles of one to about five microns or smaller also are contained in exhaust gases. Due to their small size and electrostatic charge, they remain in suspension indefinitely unless forced to settle by artificial mechanical or electrostatic forces.

Without control, solid particles result from burning at these rates:

Garbage incineration: 20 lb. per 1,000 lb. garbage
Coal Furnaces: 100 lb. per 1,000 lb. coal
Oil Furnaces: 2 lb. per 1,000 lb. oil
Diesel engines: 80 lb. per 1,000 gal. fuel
Cars: 0.3 lb. per 1,000 gal. gasoline.

Untreated exhaust gases from boiler furnaces may contain concentrations up to 5 to 20 gr. per cu. ft. (1 lb. = 1,000 gr.). The air we breathe should not contain more than 0.005 gr. per cu. ft. of air. In towns the air usually contains 0.001 gr. per cu. ft.

Pollen from certain trees, grasses and weeds, mainly ragweed pollen (20 to 50 mu.), also pollute the air and cause hay fever at concentrations of 3 to 6 pollen per cu: ft. of air and higher.

E. Liquid Pollutants

Water droplets of 5 to 100 mu. are contained in natural fog. Larger droplets form rain. Much smaller particles, down to 0.5 mu., are often present in artificial mists and fogs of acids, such as sulphuric acid or nitric acid.

F. Gaseous Pollutants

These are the most dangerous and difficult to control.

Carbon monoxide is highly toxic, colorless, odourless, non-irritating and cannot be perceived by the senses. When inhaled it passes into the bloodstream and decomposes the blood particles, so that oxygen cannot be carried through the body.

If instant death is said to occur at 100-percent decomposition of blood particles, death in a few minutes is caused by 80-percent; unconsciousness and death after several hours by 50 to 60; mental confusion, dizziness, and impairment of vision and hearing by 30 to 50; headache and shortness of breath at 20, and impaired alertness and tiredness at 10. Blood samples taken from taxi drivers have shown 8 to 20 percent.

The maximum allowable concentration of carbon monoxide in air is said to be 100 ppm. for 8 hr. If exposure lasts a day or more, the concentration should be less than 10 ppm.

Carbon monoxide has about the same density as air. It does not rise and collects along highways, its main origin being exhausts from automobiles. It is emitted at a rate of 3,200 lb. per 1,000 gal. of gasoline at cruising speed, and four times as much during idling.

Los Angeles and Toronto report carbon-monoxide concentrations above and near the pavement along super highways of 24 to 45 ppm., with a peak of 73. The concentrations, 50 ft. to the side, decreased to 20 to 40 ppm., yet a peak of 83 was measured.

Nitrogen oxides are also toxic and give no warning by odour or color. They form corrosive acids in the lungs, reducing resistance to pneumonia, and cause coughing irritation, headache and loss of appetite.

A concentration of 70 ppm. causes immediate irritation in the nose, throat and chest. Concentrations of 2 ppm. cause damage to vegetation and reduce crops in quality and quantity. Six ppm. are believed permissible even if breathed continuously for 8 hrs.

Nitrogen oxides originate from all kinds of combustion. Industrial furnaces emit as much as 500 ppm., automobile engines up to 4,000. Quantities of nitrogen oxides develop from: Oil furnaces 13 lb. per 1,000 lb. oil, Gas furnaces 8 lb. per 1,000 lb. gas, Coal furnaces 4 lb. per 1,000 lb. coal, Cars 50 lb. per 1,000 gal. gasoline, Diesel engines 75 lb. per 1,000 gal. fuel oil, Waste incinerators 2 lb. per 1,000 lb. garbage.

Sulphur oxides are colorless and have a pungent and suffocating odour. At concentrations of 4 ppm. breathing is difficult, and at 6 ppm. immediate irritation of the nose is evident. Asthma and other respiratory ailments are caused by sulphur oxides; resistance to pneumonia is reduced.

Sulphur-oxide concentrations during air-pollution disasters were surprisingly low: London, 1952, 0.56 ppm.; Donora, 1948, 2 ppm. Reactions with other pollutants, mainly ozone, are blamed for the ill effects.

Sulphur oxides originate mainly from metallurgic smelters, sulphur-acid production and fuel furnaces. On contact with water, aggressive acids are formed, causing damage and corrosion of buildings, and death of vegetation.

If not controlled, sulphur oxides are emitted in these quantities: Metal smelters 400 lb. per 1,000 lb. metal produced, Oil furnaces 25 lb. per 1,000 lb. fuel oil, Cars 17 lb. per 1,000 gal. gasoline, Diesel engines 15 lb. per 1,000 gal. fuel oil.

Hydrogen sulphur (or hydrogen sulphide) is toxic and has an obnoxious odour even at 0.1 ppm. On contact with air, it is oxidized to sulphur dioxide and subsequently forms sulphuric acids in the atmosphere, causing corrosion of buildings, discoloration of lead paints and damage to vegetation.

Fluorides, in various solid and gaseous combinations, are emitted from fertilizer plants, aluminum plants and certain furnaces. Nearby vegetation is often damaged, affecting the teeth of grazing cattle. Under long exposure the digestive enzymes are weakened and concentrations of 0.1 ppm. may cause damage to vegetation. Breathing air should not contain more than 3 ppm. and only for short periods.

Aldehydes are colorless, with a stinging, biting or fruity odour, and cause ailments as described before. They combine with body tissue to produce acids, similar to the sting of a bee. Stimulated by sunlight and nuclear radiation, aldehydes proceed through a chain of reactions, the intermediate or end products of which may be more dangerous than the aldehydes themselves.

Air with a concentration of 50 ppm. of formaldehydes in unendurable to breathe; 5 ppm. are said to be permissible, yet concentrations of 0.25 bring water to the eyes of sensitive persons.

Aldehydes (estimated as formaldehydes) are emitted by: Furnaces 5 - 15 lb. per 1,000 lb. fuel, Cars 18 lb. per 1,000 gal. gasoline, Diesel engines 30 lb. per 1,000 gal. fuel oil.

Organic vapors and hydrocarbons: A large number of hydrocarbons are emitted from combustion and many cause obnoxious odours. To blame are: Car exhausts 200 - 400 lb. per 1,000 gal. gasoline, Car-leakage losses 200 - 400 lb. per 1,000 gal. gasoline, evaporation at gas stations 100 lb. per 1,000 gal. gasoline.

This attacks any type of matter, causing a change in the various substances, such as transformation of hydrocarbons into aldehydes, glycols, acids and peracids, which aggravates the dangers of air pollution. Thus a concentration of 0.4 ppm. of ozone will reduce considerably the permissible concentrations of other pollutants while the presence of ozone alone is not dangerous.

Studies reveal that ozone causes scars in the respiratory tract, opening the tissue for easier attack by sulphur oxides. Ozone also is believed to reduce the capacity of the digestive enzymes.

Combinations of several polluting substances present a serious problem. The interactions of various pollutants are practically unknown, especially under the influence of radiation.

Humidity influences the nuisance value of pollutants. A concentration of a certain gas is easier to endure if the air is dry rather than humid. Relative humidity of 70 percent appears to be a limit where air pollution becomes a greater nuisance. On the other hand, rain has a cleaning effect.

Radiation from the sun, space particles, and man-made atomic explosions causes a variety of additional reactions that change the pollutants in substance. Ions become free, isotopes develop and cannot be controlled, new and aggresive substances are formed. The combination of air pollutants and radiation thus is an unknown dangerous phenomenon.

Civic Administration: March, 1962

Appendix B

PROVINCE OF ALBERTA

AMBIENT AIR QUALITY STANDARDS

SEPTEMBER 1970

Department of Health
Division of Environmental Health

AMBIENT AIR QUALITY STANDARDS

PURPOSE

The purpose of this outline is to establish minimum acceptable standards of ambient air quality to protect the health and welfare of all citizens, enhance and maintain the quality of the Province's air resource and prevent insofar as possible deleterious effects to animals, plants and property.

DEFINITIONS

(1) Ambient Air Quality Standard

The numerical expression of pollutant limitations in the ambient air to minimize deleterious effects on human, plant or animal life and welfare. The standards consists of two parts - a specified concentration level for a particular air contaminant and the time - averaging interval over which that concentration level is measured.

(2) Standard Conditions

For the purpose of this outline, all measurements and calculations shall be referenced to a temperature of 20°C and a barometric pressure of 760 mm. of mercury, where applicable.

AMBIENT AIR QUALITY STANDARDS

The following ambient air quality standards as tabulated are applicable to all areas of the Province of Alberta unless otherwise indicated. The ambient air quality standards are specified in Table I.

The maximum calculated ground level concentration standards utilized in the air management for pollution control and designed in consideration of the ambient air quality standards are tabulated in Table II. The applicable ground level concentration calculations will be the latest Provincial Board of Health approved calculation methods. Where two or more point sources are located in close proximity the maximum ground level concentration shall take into account the cumulative effect of all sources.

The ambient atmospheric concentrations of all substances not specified herein shall not exceed levels considered deleterious to human, plant or animal life and welfare as established by the control authority.

METHODS OF MEASUREMENT

(1) Air pollutants shall be measured by the method or methods listed in Table III or by any other method approved by the Provincial Board of Health.

(2) A minimum of three-quarters of the total possible readings for each specific time averaging period, shall constitute a valid representation.

(3) Annual averages shall be determined on the basis of any consecutive twelve month interval beginning on the first day of December.

ABBREVIATIONS USED IN THIS REGULATION

°C = degrees centigrade

cm. = centimeter

COH = coefficient of haze

gm. = gram

hr. = hour

l. = liter

m. = meter

mm. = millimeter

mg. = milligram (10^{-3} gm.)

mi. = mile

min. = minute

mo. = month

ppm. (vol.) = parts per million (volume basis)

ppm. (wt.) = parts per million (weight basis)

sq. = square

ug. = microgram (10^{-6} gm.)

TABLE I

AMBIENT AIR QUALITY STANDARDS

›LLUTANT	CONCENTRATION UNIT	AVERAGE CONCENTRATION FOR APPLICABLE TIME PERIOD 1 HR.	24 HR.		METHOD OF MEASUREMENT
UORIDES ; HF)	ppm. (vol.)		.0040		Volumetric
	mg./m^3		.0033		
IORIDES orage for stock (dry wt.)	ppm. (wt.)			35.0	Gravimetric
	mg./1			35.0	
TAL OXIDANTS O_3)	ppm. (vol.)	.15	.10	90% of readings per month <.07 ppm. (vol.) (.137 mg./m^3)	Volumetric
	mg./m^3	.29	.20		
TAL OXIDES NITROGEN NO_2)	ppm. (vol.)	.30	.10		Volumetric
	mg./m^3	.56	.19		
RBON MONOXIDE)	ppm. (vol.)	60.0		8 hour average 15.0 ppm. (vol.) 17.2 mg./m^3	Energy Transfe
	mg./m^3	68.7			
DROGEN SULFIDE ;)	ppm. (vol.)	.030	.005		Volumetric
	mg./m^3	.042	.007		
FUR DIOXIDE 2)	ppm. (vol.)	.30	.10		Ionization
	mg./m^3	.79	.26		
LING INDEX	coh	90% of average readings per month<1.0		Annual Average <.45	Optical
PENDED ICULATES	mg./m^3		100		Gravimetric
AL DUSTFALL *	tons/sq. mi./ 30 days			15.0 residential area 45.0 residential and commercial area	
	mg./cm.^{2}/ 30 days			0.525 residential area, 1.575 industrial and commercial area	Gravimetric

* due allowance shall be made for

MAXIMUM CALCULATED GROUNDLEVEL CONCENTRATION STANDARDS

POLLUTANT	CONCENTRATION UNIT	MAXIMUM ACCEPTABLE CONCENTRATIONS FOR APPLICABLE TIME PERIOD		LAND US
		30 MINUTE	OTHER	
ULFUR DIOXIDE	ppm. (vol.)	.2		urban and arable agricultural areas
ULFUR DIOXIDE	ppm. (vol.)	.3		all other areas (1
ULFUR DIOXIDE	ppm. (vol.)		1.0 (2)	
YDROGEN SULFIDE	ppm. (vol.)	.01 (3)		all
XIDES OF NITROGEN	ppm. (vol.)	.2		urban
XIDES OF NITROGEN	ppm. (vol.)	.3		rural
LUORIDES as HF	ppm. (vol.)	.001		all
MMONIA	ppm. (vol.)	2.0		all

Footnote: 1 - In forested areas due allowance must be made for height of trees for stack height calculations.

2 - To be utilized for short period emergency flaring only (less than 1 hour).

3 - Where incineration is feasible, the H_2S must be incinerated to SO_2.

TABLE III

METHODS OF AIR CONTAMINANT MEASUREMENT

AIR CONTAMINANT	SAMPLING METHOD	SAMPLING INTERVAL	ANALYTICAL METHOD *
Particulates			
Suspended	High Volume Filtering	24 hours	Gravimetric (Air Pollution Measurement of the National Air Sampling Network, 1957-61, U.S. Dept. of Health, Education and Welfare Cincinnati, Ohio, pp. 6-8, 19
Settleable	Dustfall Jar	30 days	Gravimetric (ASTM D 1739-62)
Soiling Index	Spot Tape Filtering	2 hours	Light transmittance (Hemeon, Haines and Ide: Air Repair Vol. pp. 22-28, 1953)
Sulfur Dioxide	Conductivity	continuous	Electrical conductance and ionization
Hydrogen Sulfide	Spot Tape	1 hour	Light transmittance, lead acetate impregnated tape, (Sensenbaugh, J.D. and Hemeon, W.C.L. Air Repair Vol. 4, p. 5, May 1954
Carbon Monoxide	Optical	continuous	Infrared Absorption (Air Pollution A.C. Stern ed., Vol. 2, pp. 43 434, Acad. Press. 1968)
Oxidants	Volumetric	continuous	Colorimetric, Neutral Potassium Iodide Method (ASTM D 2011-65 Coulometric, Neutral Potassium Iodide Method
Oxides of Nitrogen			
Nitrogen Dioxide	Volumetric	continuous	Colorimetric - Saltzman Reagent
Total Oxides of Nitrogen	Volumetric	continuous	Coulometric - Neutral Potassium Iodide Method
Hydrogen Fluoride	Volumetric	continuous, 2 hour or 24 hours	Colorimetric, SPADN Method (Bellacke and Schouboe, Anal. Chem. 30; p. 2032, 1958)

Subject to revision by the Provincial Board of Health

Appendix C

SURFACE WATER QUALITY CRITERIA

PROVINCE OF ALBERTA

Prepared by

WATER POLLUTION CONTROL SECTION

DIVISION OF ENVIRONMENTAL HEALTH

Authorized by

PROVINCIAL BOARD OF HEALTH REGULATIONS

Respecting the Disposal of Waste Water and the Control of

Water Pollution, Section 39-2-1

HON. J. D. HENDERSON
Minister of Health

P. D. ROSE, M.D.
Deputy Minister of Health

August, 1970

SURFACE WATER QUALITY CRITERIA FOR ALBERTA

A. FOREWORD

This document replaces "Summary Surface Water Quality Criteria - Province of Alberta" first published in 1969. The criteria used herein are based on current knowledge and will be subject to periodic review and revision as a result of advances in the technology of water production and waste treatment and changes in water quality requirements for the preservation of our environment.

B. GENERAL POLICY

The water quality management objectives are to conserve water and to protect, maintain and improve its quality for the protection of public health and, within economic limits, for the following purposes:

(a) preservation and protection of water supplies;
(b) encouragement of economic development;
(c) preservation of aesthetic values; and
(d) preservation of fish and wildlife.

The Provincial Board of Health has not felt it desirable to set up rigid effluent or receiving water standards, but has chosen instead to examine each case of waste disposal and water pollution on its own merits considering each case from the broader water quality management point of view. Guidelines or criteria are, of course, necessary to assist in the evaluation of each case and these are contained in the following comments and tables. Interpretation is based on field data, the various uses of the water body in question and the effects thereon, and the practicability of treatment.

The factors that influence the degree of pollution and which are used to assess the degree of treatment required include, in addition to the nature and volume of the polluting waste, the effects of pH, climate, dilution, natural quality and character of the receiving water, mixing, chemical and biological changes, velocity of flow, specific requirements of various beneficial uses, and other variables.

Each substance that may enter a body of water is deemed to be a potential pollutant - potential in the sense that if concentrated sufficiently, it can adversely and unreasonably affect such waters for one or more beneficial uses and yet if diluted adequately it will be harmless to all beneficial uses. The concentration of these potential pollutants in water is a function not only of the amount of polluting substance added but also of the factors of dilution, self-purification, synergism and antagonism.

There are requirements that may be specified as universally applicable without any need for studies or surveys. They represent the minimum conditions that must be met regardless of any other circumstances and can be

justified solely on the basis of aesthetics. These minimum conditions will demand the equivalent of primary treatment of sewage. Then there are supplementary requirements, the determination of which may require time for data assembly and evaluation, to protect the various uses of receiving waters.

C. GENERAL OBJECTIVES FOR EFFLUENT DISCHARGES

The following basic objectives are applicable to all waters receiving effluents in the context that municipal, industrial, agricultural or other discharges should be:

1. free from substances in concentrations or combinations which are toxic or may be harmful to human, animal or aquatic life;

2. free from substances that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life of waterfowl;

3. free from debris, oil, grease, scum or other materials in amounts sufficient to be noticeable in the receiving water;

4. free from color, turbidity or odour-producing materials that would:

   (a) adversely affect aquatic life or waterfowl;
   (b) significantly alter the natural color of the receiving water;
   (c) directly or through interaction among themselves or with chemicals used in water treatment, result in undesirable taste or odour in treated water;

5. free from nutrients in concentrations that create nuisance growths of aquatic weeds or algae in the receiving water.

D. SPECIFIC SURFACE WATER QUALITY OBJECTIVES

These criteria are intended as a means by which the administrative authority can assess the quality of water and municipal and industrial wastewater effluents. They will also be useful to industries, municipalities and consulting engineers in determining the type and degree of treatment required to maintain suitable quality of the surface waters of the province.

The specific objectives listed in Table I are for evaluation of conditions except in areas in close proximity to outfalls as prescribed by the Provincial Board of Health. In the vicinity of outfalls a "zone or passage" of satisfactory quality must be considered for aquatic biota travel. The values are

considered to be the basic quality objectives in surface waters, except for those cases where more stringent objectives are required because of specific uses.

There are many instances where the natural water quality of a lake or river does not meet some of the suggested limits. In these cases, the limits obviously will not apply. It should be noted, however, that where the natural existing quality is inferior to desirable criteria, it would be unwise to permit further deterioration by unlimited or uncontrolled introduction of pollutants. Naturally occurring circumstances are not taken into account in these "Criteria" and due consideration must be given where applicable (e.g. spring runoff effect on color, odour, etc.).

TABLE I

SURFACE WATER QUALITY CRITERIA

These criteria have been prepared in co-operation with the Provinces of Saskatchewan and Manitoba and represent water quality suitable for most uses either through direct use or prepared for use by an economically practical degree of treatment.

Parameter		Criteria
1. Bacteriology (Coliform Group)	(a)	In waters to be withdrawn for treatment and distribution as a potable supply or used for outdoor recreation other than direct contact, at least 90 per cent of the samples (not less than five samples in any consecutive 30-day period) should have a total coliform density of less than 5,000 per 100 ml and a fecal coliform density of less than 1,000 per 100 ml. (The Maximum Permissible Limit of total coliform organisms in a single sample shall be determined by the Provincial Board of Health based on the type and degree of pollution and other local conditions existing within the watershed.)
	(b)	In waters used for direct contact recreation or vegetable crop irrigation the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 1,000 per 100 ml total coliforms, nor 200 per 100 ml fecal coliforms, nor exceed these numbers in more than 20 per cent of the samples examined during any month, nor exceed 2,400 per 100 ml total coliforms on any day.
2. Dissolved Oxygen		A minimum of five mg/l at any time.
3. Biochemical Oxygen Demand (BOD_5)		Dependent on the assimilative capacity of the receiving water. The BOD_5 must not exceed a limit which would create a dissolved oxygen content of less than five mg/l.
4. Suspended Solids		Not to be increased by more than 10 mg/l over background value.
5. pH		To be in the range of 6.5 to 8.5 pH units but not altered by more than 0.5 pH units from background value.

6. Temperature — Not to be increased by more than 3°C above ambient water temperature.

7. Odour — The cold (20°C) threshold odour number not to exceed eight.

8. Colour — Not to be increased more than 30 colour units above natural value.

9. Turbidity — Not to exceed more than 25 Jackson units over natural turbidity.

10. Organic Chemicals

Constituent	Maximum Concentration (mg/l)
Carbon Chloroform Extract (CCE) (includes Carbon Alcohol Extract)	0.2
Methyl Mercapton	0.05
Methylene Blue Active Substances	0.05
Oil and Grease	substantially absent no irridescent sheen
Phenolics	0.005
Resin Acids	0.1

11. Pesticides — To provide reasonably safe concentrations of these materials in receiving waters an application shall not exceed 1/100 of the 48-hour TL_m. Persistent insecticides such as DDT, Aldrin, Dieldrin, Endrin, Heptachlor should not be used on or near surface waters.

12. Inorganic Chemicals

Constitutent	Maximum Concentration (mg/l)
Boron	0.5
Copper	0.02
Fluoride	1.5
Iron	0.3
Manganese	0.05
*Nitrogen (Total Inorganic and Organic)	1.0
*Phosphorus as PO_4 (Total Inorganic and Organic)	0.15
Sodium (as per cent of cations)	between 30 and 75
Sulphide	0.05
Zinc	0.05

* These criteria are presently under study and may require adjusting according to naturally occurring concentrations or conditions.

NOTE: The predominant cations of sodium, calcium and magnesium and anions of sulphate, chloride and bicarbonate are too variable in the natural water quality state to attempt to define limits. Nevertheless, in order to prevent impairment of water quality, where effluents containing these ions are discharged to a water body the permissible concentration will be determined by the Provincial Board of Health in accordance with existing quality and use.

13. Toxic Chemicals

Constituent	Maximum Concentration (mg/l)
Arsenic	0.01
Barium	1.0
Cadmium	0.01
Chromium	0.05
Cyanide	0.01
Lead	0.05
Mercury	0.0001
Selenium	0.01
Silver	0.05

14. Radioactivity — Gross Beta not to exceed 1,000 pCi/l.
Radium 226 not to exceed three pCi/l.
Strontium 90 not to exceed 10 pCi/l.

15. Unspecified Substances — Substances not specified herein should not exceed values which are considered to be deleterious for the most critical use as established by the Provincial Board of Health.

APPENDIX

EXPLANATORY NOTES FOR PARAMETERS AND COMMENTS ON THE WATER QUALITY CRITERIA

1. Antagonism – the process of nullifying or modifying the effect or action of a substance by another substance concurrently present.

2. Biochemical Oxygen Demand (BOD_5) – usually a five-day, 20°C test (BOD_5) this parameter is a measure of organic matter and thereby a measure of the degree of pollution.

3. Boron (B) – is harmful to boron sensitive plants, and may have a long-term effect on health if ingested in large amounts over protracted time.

4. Carbon Chloroform Extract (CCE) and Carbon Alcohol Extract (CAE) – a measure of organic materials such as insecticides, pesticides, herbicides and synthetic industrial chemicals which are toxic in trace quantities.

5. Chloride (Cl) – causes a salty taste, accelerates corrosion, interferes with some industrial processes and is detrimental for irrigation.

6. Coliform Bacteria – used as an indicator of the bacteriological quality of water as related to the possible presence of disease producing organisms.
Fecal coliforms are less likely to grow outside the intestinal tract of warm-blooded animals, and are somewhat less hardy than the total coliforms.

7. Colour – causes undesirable aesthetic effect on water used for domestic supplies and is detrimental for various industrial processes.

8. Copper (Cu) – imparts an undesirable taste in drinking water, is objectionable for canning and is toxic to fish and aquatic life.

9. Dissolved Oxygen (DO) – the effect of organic pollution is reflected in the resulting depletion of DO; an adequate level of DO is required to maintain a proper balance of fish and aquatic life, for natural river purification and to prevent obnoxious anaerobic conditions.

10.	Fluoride (F)	-	optimum concentrations of fluoride in drinking water will reduce dental caries whereas excessive amounts will induce dental fluorosis.
11.	Iron (Fe)	-	stains laundry and plumbing fixtures, imparts taste and interferes with ion exchange units.
12.	Magnesium (Mg)	-	in combination with sulphate causes a laxative effect and imparts taste.
13.	Manganese (mn)	-	stains laundry and plumbing fixtures and is undesirable in many industrial processes even in low concentrations.
14.	Methylene Blue Active Substances (MBAS)	-	a term used to describe synthetic detergents and the method of detection. Synthetic detergents reduce the rate of reaeration, may cause taste in water supplies, are toxic to fish in high concentrations and cause foaming.
15.	Methyl Mercaptan	-	in low concentrations cause taste and odour and are toxic to fish.
16.	Nitrogen	-	a nutrient for plant growth. Ammonia nitrogen (NH_3N) creates oxygen demand, indicates pollution, can be toxic to fish, interferes with water treatment and brewing. Nitrate (NO_3) levels in excess of 40 mg/l as nitrate can be harmful to infants.
17.	Oils and Grease (Ether Solubles)	-	objectionable from an aesthetic standpoint, reduce reaeration, are toxic to fish, taint fish flesh, create taste and odours, interfere with water treatment and waterfowl.
18.	Pesticides	-	any substance or mixture of substances intended, sold or represented for use in preventing, destroying, repelling or mitigating any insect, nematode, rodent, predatory animal, bacteria, fungus, weed or other form of plant or animal life or virus, except a virus or bacteria or fungus in living man or animals.
19.	pH	-	an index of hydrogen ion activity.
20.	Phenolics	-	minute concentrations impart a taste to water which is intensified by chlorination; small amounts taint fish flesh.

21.	Phosphorous	-	a nutrient for plant growth, interferes markedly with coagulation, often measured as phosphate (PO_4).
22.	Radioactivity	-	is especially significant in relation to human health, first through the direct consumption of water and second through the ingestion of agricultural products, stock and aquatic life that have accumulated radioactivity.
23.	Resin Acids	-	can be toxic to fish.
24.	Sodium (Na)	-	in combination with sulphate causes a laxative effect and boiler foaming, undesirable for people on a salt free diet, detrimental to irrigation.
25.	Sodium (as a per cent of cations - % Na)	-	a measure of the suitability of water for irrigation.
26.	Sulphate (SO_4)	-	see references to sodium and magnesium.
27.	Sulphide	-	can be toxic to fish, causes taste and odours and is detrimental for industrial use.
28.	Suspended Solids (SS)	-	a measure of material exceeding colloidal size. These solids interfere with self-purification, lead to sludge deposits, damage fisheries and create a nuisance aesthetically.
29.	Synergism	-	the process of amplifying or enhancing the effect or action of a substance by another substance concurrently present.
30.	Temperature	-	affects palatability, water treatment, industrial processes, self-purification and aquatic life.
31.	Threshold Odour Number (TON)	-	measure of odour producing substances in water; high concentrations of odour require extensive treatment.
32.	Tl_m	-	median tolerance limit or the concentration that kills 50 per cent of the test organisms in a bioassay within a specified time span, usually 48 hours or less.

33. Total Dissolved Solids (TDS) – a measure of the sum of individual dissolved minerals in water; highly mineralized water is detrimental to health, agriculture and industry.

34. Toxic Chemicals – often related to heavy metals these include arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), cyanide (CN), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), and silver (Ag). Because of the ability of organisms to concentrate these chemicals and because of their toxicity to humans in minute amounts, the concentration of any toxic chemical must be kept very low.

35. Turbidity – a measure of the colloidal and suspended solids load; it has a bearing on aesthetics, water treatment, aquatic life and industrial use.

36. Zinc (Zn) – produces an undesirable taste, and can be synergistic.

NOTE: Analytical procedures used generally conform to "Standard Methods for the Examination of Water and Wastewater", latest edition published by the American Public Health Association, American Water Works Association and Water Pollution Control Federation.

Appendix D

Inventory for Source Types

The following classification is suggested for determining both the quantity and type of pollutant sources from a wide range of scattered activities. The breakdown may be applied to any region where a source inventory is required but alterations must be paid also to sources and emissions which are not within the region but which may contribute significantly to the air quality in the study area.

Class I. Fuel Burning for Heat and Power Production

This includes the operating of heating equipment utilizing coal, oil, gas and wood for power production, space heating, and hot water. Included in this category are the following sources:

A. Utilities. These are the large steam-electric generating plants, both public and private.

B. Residences. These include single and multiple dwellings such as private homes, duplexes, and apartment houses.

C. Industrial Establishments. This category includes:

1. Manufacturing; light and heavy, in accordance with the Standard Industrial Classification Scheme of the U.S. Department of Commerce.
2. Commercial establishments such as stores, hotels, clubs, hospitals and offices.
3. Processing, including laundries, dry cleaners, garages and service stations.

Class II. Incineration

This category represents activities related to the burning of refuse. These sources include:

A. Municipal incinerators

B. Industrial and commercial incinerators

C. Residential-type incinerators

D. Apartment house incinerators

E. Open refuse-burning

Class III. Transportation

This category represents the burning of fuels for all modes of transportation. Included are:

A. Motor vehicles, powered by internal combustion or diesel engines

B. Trucks or buses (gasoline and diesel)

C. Railroad engines

D. Ships

E. Aircraft

Class IV. Industrial and Commercial

This class includes the various technological operations and processes such as:

A. Manufacturing (metallurgical plants, chemical plants, refineries, mineral production, etc.)

B. Agricultural operations (spraying, dusting and field burning)

C. Commercial activities (dry cleaning, spray painting, printing)

D. Miscellaneous (sewage treatment, construction, demolition)

The pollutant emissions themselves can be divided into two main groups: particulate and gaseous. The former group includes solid airborne particles such as dust, fly ash, smoke, soot and fumes. Gaseous pollutants include the ideal gases as well as vapors.

Appendix Emission Sources

Source: "Air Pollution and Urban Planning"
by T. W. McCaig, Engineering Digest,
October, 1969, p. 57 - 58

Sources of contaminant emissions include gaseous, vaporous and particulate discharges from the combustion of fossil fuels, the combustion of waste fuels and industrial processes. For convenience, the emissions mainly influencing concentrated populations are categorized into collective atmosphere discharges from:

Heat Energy Producing Plants

Electric Energy Producing Plants

Waste Disposal Plants

Industrial Process Plants

Transportation

Residences and Commercial Undertakings

Miscellaneous

Heat Energy Producing Plants

Central installations for the production of heat energy comprise mainly heating plants for hospitals, institutional complexes and other similar buildings. Emissions are mainly the result of the combustion of coal, fuel oil or natural gas in large boiler furnaces. The variation in emission rates from a heating plant serving an institution, such as a hospital, will be governed almost entirely by climatic conditions. The highest emissions will normally coincide with the lowest ambient air temperatures. Some large institutions will employ the boiler plant for air conditioning and possibly electric power production. In these cases, emissions will be influenced further by demands from such services' ancillary systems.

Electric Energy Producing Plants

Installations for the sole production of electric energy employ oil engines, gas turbines or steam turbines as prime movers. At present, principally fossil fuels, such as oil, gas and coal, supply the prime energy source. Nuclear energy sources are not considered an immediate threat to air quality because emissions are closely controlled and plants are usually located remote from large centres of population. Oil-engine driven electric generating installations are usually associated with relatively light emissions, but recent developments have indicated that plants of larger capacity, fuelled with sulphur bearing heavy oil, may become economic in the near future. The air pollution considerations of proposals for such installations will require careful study.

The aircraft type, gas turbine driven, peaking electric generator is highly attractive to modern electric systems planners. The emissions occur usually only during peak power demand periods. With natural gas as a fuel, contaminant emission rates are usually light.

The bulk electric power generated in the world is produced from steam raised in fossil-fuel fired boiler plants (steam turbines). They form a major source of atmospheric sulphur dioxide and oxides of nitrogen. Much of the base load at present carried by these installations may, for reasons of air pollution alone, have to be transferred in the future to nuclear fuelled plants.

Waste Disposal Plants

The variation in the rate of emission from waste disposal facilities such as refuse incinerators and effluent treatment plants is contingent mainly on factors of design and operation. A municipal incinerator may be designed for an 8-hour, 16-hour or 24-hour day operation. An 8-hour day operation will constitute at least three times the intensity of emission during operational periods of a similar plant designed to consume the same refuse quantity on a 24-hour basis. Waste from urban communities varies both in quality and quantity with the type of local industry and the time of year. During the summer months, large quantities of grass clippings and other garden refuse characterise the waste to be incinerated. In winter months packaging materials form a greater proportion of the waste input.

Industrial Process Plants

Many industrial processes are operated on a 24-hour, 7-day week basis and therefore the time of the day, day of the week, or season of the year, have little effect on atmospheric emissions. Pollution is released at all levels, from ground level, building roof monitors and stacks, and the resultant ground level concentration of contaminants is therefore influenced mainly by atmospheric ventilation. The siting of heavy industry is strongly influenced by the availability of cheap electric power and abundant water. In the future an additional factor will influence site selection, that of atmospheric ventilation in relation to local urban communities.

Industrial process plants also have a requirement for heat energy and this may be supplied, as in the paper industry, by combustion of waste products. Emissions arising from this source usually vary uniformly with the production process.

Transportation

The emissions resulting from transportation form an increasing proportion of total emissions. Forecasts of the future contaminant load in an urban area should reflect recent vehicular emission control trends and the increasing momentum of the adoption of rapid transit facilities in large urban communities.

The emissions from transportation will vary in accordance with vehicle speed and traffic density. Traffic load will fluctuate sharply from a maximum at rush-hour periods to a minimum during the early hours of the day. A further variation

in traffic load occurs between week-day and weekend, and yet another between summer months and winter months. Each variation in traffic load will cause a similar variation in emissions.

Residences and Commercial Undertakings

The emissions from private residences are confined mainly to discharges from heating equipment, although apartment incinerators, air conditioning plant cooling towers and other miscellaneous discharges can represent a considerable localized air pollution problem. Apart from these miscellaneous items, residential and commercial area emissions vary in accordance with ambient air temperature and wind chill.

Miscellaneous

In this category would be considered all emissions not included in the above, such as odours, natural atmospheric contamination from vegetation, blowing dust and specialized nuisances. The variability of each item of emission would be assessed on the basis of the factors affecting its release to the atmosphere, such as allergen pollens during certain months.

Appendix E Charts that give Examples and Strengths of Various Industrial Wastes

	Source	Characteristic	Production Unit	Gal per Unit	Strength Pop. Eqv. per Unit	Strength BOD mg/L	Strength Susp. S mg/L
finery	Leaks, spills, tank draw-offs, caustic sludge; chemical emulsions; distillate separator condensates; tank sludges; spent catalysts	Oil; organic, Sulfur and nitrogen compounds, mercaptides and esters, sulfides acids, alkalies, phenols; oil emulsions	100 bbl Crude Oil	75,000	75		40
g House	Stockyard run off; killing floor; blood; carcass washing	Organic content; grease, blood hair flesh high nitrogen content (30-	Ton of Kill	4150	Stockyards killing floor Blood Carcass washing	825 32,000 4,600 13,000	220 3700 8300 15200
& Pulp	Spent white water and coating bleach wastes; alkalii washings; spent sulfite liquors; kraft liquors; deinking liquors; chemical solutions	Vary with type of plant. Deinking wastes are alkaline, high in BOD. Kraft liquors are alkaline, hid in BOD; lignin & toxic substances present. Sulfate wastes are acid, high in BOD, total solids.	Ton of Product	Groundwood #2400 Soda #49000 Sulfate Kraft #6500 Sulfate #51000	78 300 410 1150	650 120 125 450	1720
	Hide soaking, fleshings, lime vat discharges, hair, wash waters, pickle liquors, spent vegetables, tanning liquors chrome tanning liquors, bleach liquors	High organic & inorganic content; high BOD and dissolved solids. Colored. Fleshings increase BOD, some liquors increase solids, BOD and alkalinity.	100 lb of Hide	950	81	1700	3000
es	Cleaning and dyeing operations, etc.	Desizing, kier and bleach wastes are high in detergent and organic content Dye wastes are colored; sizing wastes acid; mercerizing wastes, alkaline Most solids are dissolved.	100 lb. of Goods	Sizing 6-10 Desizing 100 Kier 174 Bleach 120 Kier Bleach 1150 Souring 320 Sulfur Dye 545 Vat Dye 1900 Mercerizing 3000	0.25 8.75 10.8 1.8 6.9 1.2 35.4 13.3 8.25	820 1750 1240 300 120 75 1300 140 55	

Source: (Charts courtesy of B.I.F. Industries of Canada (1961) Ltd., Subsidiary of the New York Air Brake Company.)

	Source	Characteristic	Production Unit	Strength Cal per Unit	Strength Pop. Eqv. per Unit	Strength BOD mg/L	Strength Susp. Sol mg/L
ic	Spent broths or beers; spoiled batches chemical wastes; cooling	Usually clear; high organic content; may be toxic and produce tastes in water supplies				Penicilin 1200	Tr
						Streptomycin 2500	Tr
						Aureomycin 7000	Tr
ct	Residue from steam distillation of gas liquor; final cooling waters; acid & alkali wash waters; H_2S wash waters	Phenols, cyanides, calcium chloride from gas liquor; naphthalene and cyanides in cooling waters; excess acid and alkli in light oil washings	Ton of Coal Coked	300	12.75	85	
	Washing and preparation of raw materials; floor & equipment wash-down; blanching silage	Organic content high; high oxygen demand; high suspended solids due to skins, pulp, seeds, etc.	Case of No. 2 Cans	Beans 35	0.7	400	60
				Beets 37	9.25	5000	1120
				Corn 25	3.7	3000	1120
				Peas 25	1.7	1400	950
				Corn Ensilage	-	27000	-
				Tomatoes 7-70	1-10.5	3000	950
				Citrus 50	4.5 4.5	1800	300
	Lost & spoiled products; washing; whole milk, whey, casein or buttermilk; (on type of plant)	Organic content high high oxygen demands high suspended [illegible] contain syndets	1000 lb. Milk	Receiving 180	4.5	500	Total Sol 700
				Bottling 250	7.0	550	600
				Cheese 210	10.5	1000	3000
				Condense 150	9.75	1300	1200
				Creamery 100	6.25	1250	1500
				Dry Milk 150	3.75	500	1200
ion	Spent mash and hops; rinse water from cookers, fermenters; aging vats, yeast recovery, floor washings.	Organic content high; high [illegible] solids high oxygen demand; Brewery wastes high in yeast distillery wastes high in nitrogen	Breweries bbl of beer	Receiving 180	38	1700	750
			Distilleries 1000 bu. grain	650,000	13,080	400	300

Appendix F

Industrial Districts in the City of Edmonton

Selected Zoning Regulations

Section 28 M-1 INDUSTRIAL DISTRICT

USES PERMITTED AND REGULATIONS

(1) Performance Standards

Subject to all other provisions of this Bylaw on any site, in any district defined, designated or described in this Bylaw as an M-1 Industrial District, a person will be issued a permit only for the uses more particularly described in Subsection (3) of this Section, and only if the use and operation proposed for a site is conducted at all times so as to ensure that the use and operation will not cause nor permit any external objectionable or dangerous condition apparent beyond any building housing processes wherein such effects may be produced, including but without limiting the generalities thereof, the following objectionable features, namely:

(i) Noise
(ii) Vibration
(iii) Smoke, dust and other kinds of particulate matter
(iv) Odour
(v) Toxic and noxious matters
(vi) Radiation hazards
(vii) Fire and explosive hazards
(viii) Heat, humidity and glare.

(3) Uses

Subject to all other provisions of this Bylaw, on any site, in any district defined, designated, or described in this Bylaw as an M-1 Industrial District, permits will be issued for only such of the following uses as will comply with the performance standards and conditions of Subsections (1) and (2) of this Section, namely:

(a) Warehousing, storage, receiving, distribution, transshipment of raw materials and processed or manufactured products (including parts and components).
(b) Manufacturing.
(c) Servicing and repairing establishments.
(d) Such commercial, recreational and municipal buildings and uses as, in the opinion of the Development Officer, are unlikely to have restrictive effects upon this district and are compatible with industrial uses.
(e) Any use or building accessory to the foregoing uses.

(4) If it appears from the application that the proposed use and operation may not be conducted in compliance with the performance standards herein set forth, the Director shall refuse the application.

(6) In considering the application, the Director shall have regard to the intent of this Section, which is to establish use on the basis of

(a) appropriate performance standards; and
(b) the methods, equipment, and techniques of the applicant; and
(c) the use of neighbouring lands and zoning districts and the compatibility of the proposed use with neighbouring lands and zoning districts.

(7) Notwithstanding anything contained in this Section, if an applicant for a permit satisfies the Director, that, while his proposed use is of a type normally associated with the uses of less restrictive or heavier industrial districts, he will nevertheless comply with the performance standards applicable to an M-1 District, the Director shall authorize that a permit be issued subject to such conditions or regulations as the Director may impose.

Section 29 M-2 INDUSTRIAL DISTRICT

USES PERMITTED AND REGULATIONS

(1) Performance Standards

Same as those for M-1 Industrial District

(2) Uses

Same as those for M-1 Industrial District

Section 30 M-3 INDUSTRIAL DISTRICT

USES PERMITTED AND REGULATIONS

(1) Performance Standards

Same as those for M-1 Industrial District

(2) Uses

Same as those for M-1 Industrial District

ACCOPRESS

2507

BR	RED	BY	YELLOW
BG	BLACK	BA	TANGERINE
BD	GREY	BB	ROYAL BLUE
BU	BLUE	BX	EXECUTIVE RED
BP	GREEN		

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